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By Authority of the
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Docket Number: BC2523PRO

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(c).

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
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☐ *Additional inventors are being named on the* *separately numbered sheets attached hereto.*

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TITLE OF THE INVENTION (280 characters max)

WAX/WATER-RESISTANT ADDITIVES FOR GYPSUM WOOD FIBER PRODUCTS

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ENCLOSED APPLICATION PARTS (check all that apply)

☒ Specification *Number of Pages:* 18 *(including any claims and abstract)*
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☒ Application Data Sheet. See 37 CFR 1.76
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METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☑ Applicant claims small entity status. See 37 CFR 1.27.
☒ A check or money order is enclosed to cover the filing fee(s).
☐ The Commissioner is hereby authorized to charge filing fee(s) or credit any overpayment to Deposit Account Number 07-0181 . A duplicate copy of this communication is enclosed for that purpose.
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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government:
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Respectfully submitted,

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CERTIFICATION UNDER 37 CFR 1.10

I hereby certify that this correspondence and the documents referred to as attached or enclosed therein are being deposited with the United States Postal Service on November 13, 2002, in an envelope as "EXPRESS MAIL POST OFFICE TO ADDRESSEE" service under 37 CFR 1.10, Mailing Label Number EF366669139US, addressed to: Commissioner for Patents, Washington, D.C. 20231.

Carlos Coronado
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Box Provisional Patent Application
Commissioner for Patents
U.S. Patent and Trademark Office
Washington, D.C. 20231

Title: WAX/WATER-RESISTANT ADDITIVES FOR GYPSUM WOOD FIBER PRODUCTS

Applicant(s): Wantling

Application No.: Unassigned

Filing Date: December 20, 2002

Enclosed:

1. Provisional Application for Patent Cover Sheet (1 pg) and duplicate thereof (1 pg)
2. Application Data Sheet (3 pgs)
3. Patent Application comprising: Specification (12 pgs); Claims (5 pgs.); Abstract (1 pg.)
4. Check in the amount of $160.00
5. Return postcard

Carlos Coronado
Typed or Printed Name

Signature

Attorney Docket No. **BC2523PRO**
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Application Data Sheet

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WAX/ WATER-RESISTANT ADDITIVES FOR GYPSUM WOOD FIBER PRODUCTS

FIELD OF THE INVENTION

The present invention relates to an additive useful in improving the water-resistance of gypsum wood fiber products. The present invention also relates to an emulsion which includes a wax or a combination of waxes, an alkyl phenol, at least one surfactant, polynaphthalenesulfonic acid, and an alkali metal hydroxide, the emulsion useful in improving the water resistance of gypsum wood fiber products. The present invention further relates to a method of making the emulsion.

BACKGROUND OF THE INVENTION

Certain properties of gypsum (calcium sulfate dihydrate) make it very popular for use in making industrial and building products; especially gypsum board. It is a plentiful and generally inexpensive raw material which, through a process of dehydration and rehydration, can be cast, molded or otherwise formed to useful shapes. The base material from which gypsum board is manufactured is the hemihydrate form of calcium sulfate (gypsum), commonly termed stucco, which is produced by the heat conversion of the dihydrate from which the water phase has been removed.

In the making of gypsum board, the gypsum slurry must flow onto a paper substrate. In a continuous process, the slurry/substrate combination is then sized by passing this combination between rollers. Simultaneous with this sizing step, a paper backing is positioned over the sized gypsum slurry. Accordingly, the gypsum slurry must possess sufficient fluidity so that a properly sized gypsum board can be made.

It is also important to the manufacture of gypsum board, that the gypsum slurry be capable of being foamed to a limited extent. Foamability refers to this ability to be foamed. When the gypsum slurry and paper substrate are passed through the sizing rollers, a certain amount of the gypsum slurry must back flow and accumulate in the rollers nip so that a steady flow of gypsum is delivered to the sizing rollers.

Because of the continuous nature of a gypsum board manufacturing process wherein the gypsum slurry flows onto a substrate which then passes through sizing rollers, the extent to which the gypsum slurry flows after it is sized is critical to maintaining the finished

product dimensions of the gypsum board. The time at which the gypsum slurry ceases its flow is referred to as the pre-set time. The set time of the gypsum slurry is also an important property. The set time refers to the amount of time it takes the gypsum slurry to be dried, under heat, to the finished, solid gypsum board.

Gypsum board absorbs water, which reduces the strength of the wallboard. Prior art products, like ordinary gypsum board, gypsum tile, gypsum block, gypsum casts, and the like have relatively little resistance to water. When ordinary gypsum board, for example, is immersed in water, the board quickly absorbs a considerable amount of water, and loses a great deal of its strength. Actual tests have demonstrated that when a 2 inch by 4 inch cylinder of gypsum board core material was immersed in water at about 70° F, the cylinder showed a water absorption of 36% after immersion for 40 minutes.

The gypsum wood fiber (GWF) product differs from conventional gypsum wallboard products in that the GWF incorporates into the established slurry both gypsum and wood fibers. For example, in addition to lumber, particleboard, fiberboard, waferboard, plywood and "hard" board (high density fiberboard) are some of the forms of processed lignocellulosic material products used in the building industry. Such materials have better tensile and flexural strength than gypsum. However, they are also generally higher in cost, have poor fire resistance and are frequently susceptible to swelling or warping when exposed to moisture. Therefore, affordable means to improve upon these use limiting properties of building products made from cellulosic material are desired.

Previous attempts to combine the favorable properties of gypsum and cellulosic fibers, particularly wood fibers, have had very limited success. Attempts to add cellulosic fibers, (or other fibers for that matter), to gypsum plaster and/or plasterboard core have generally produced little or no strength enhancement because of the heretofore inability to achieve any significant bond between the fibers and the gypsum. U.S. Pat. Nos.: 4,328,178; 4,239,716; 4,392,896 and 4,645,548 disclose recent examples where wood fibers or other natural fibers were mixed into a stucco (calcium sulfate hemihydrate) slurry to serve as reinforcers for a rehydrated gypsum board or the like.

U.S. Pat. No. 4,734,163, teaches a process in which raw or uncalcined gypsum is finely ground and wet mixed with 5-10% paper pulp. The mash is partially dewatered, formed into a cake and further dewatered by pressure rolls until the water/solids ratio is less

than 0.4. The cake is cut into green boards, which, after being trimmed and cut, are stacked between double steel plates and put into an autoclave. The temperature in the autoclave is raised to about 140° C. to convert the gypsum to calcium sulfate alpha hemihydrate. During the subsequent incremental cooling of the vessel boards, the hemihydrate rehydrates back to dihydrate (gypsum) and gives the boards integrity. The boards are then dried and finished as necessary.

U.S. Pat. No. 5,320,677 to Baig describes a composite material made from gypsum and host particles of a reinforcing material, such as lignocellulose fibers. The composite material is produced by mixing gypsum and host particles of a stronger substance, such as wood fibers, in a dilute aqueous slurry. The slurry is heated in an autoclave, preferably under pressure, to convert the gypsum to calcium sulfate alpha heimhydrate. The hot, converted slurry is discharged through a headbox onto a continuous felting conveyor of the type used in paper making operations, where the slurry is dewatered to remove as much uncombined water as possible before rehydrating the hemihydrate back to gypsum. The resulting material is a homogeneous mass comprising gypsum crystals physically interlocked with the discrete host particles. The resulting mat is then dried in heated convection or forced air drying ovens, and the dried board is cut to the desired dimensions. Baig teaches the addition of crystal modifiers to the slurry, but does not teach the addition of any additive to improve the water resistance of the final product.

These prior art products, like ordinary gypsum wallboard, gypsum tile, gypsum block, gypsum casts, and the like have relatively little resistance to water.

U.S. Patent 6,010,596 to Song teaches adding a wax emulsion containing a combination of a paraffinic hydrocarbon, montan wax, polyvinyl alcohol, water and emulsifiers to a hot slurry containing ground gypsum and wood fiber. Emulsifiers include nonionic and cationic surfactants. While still hot, the slurry is discharged through a headbox onto a continuous felting conveyor, such as the type used in paper making operations, to form a felter cake and remove as much uncombined water as possible. Song does not teach an emulsion containing the novel combination of waxes, an alkyl phenol, at least one surfactant, polynaphthalenesulfonic acid, and an alkali metal hydroxide.

SUMMARY OF THE INVENTION

Embodiments of the present invention provide an additive emulsion and a method for making the emulsion that addresses the issues of water absorption, viscosity control, stability, and slurry fluidity in the manufacture of gypsum wood fiber composites.

In one embodiment, the present invention provides an emulsion including at least one wax, an alkyl phenol, at least one surfactant, a polynaphthalenesulfonic acid, an alkali metal hydroxide, and water. The polynaphthalenesulfonic acid and the alkali metal hydroxide react to give a salt of polynaphthalenesulfonic acid. Emulsions of this embodiment may be added to hot, even boiling, water without the emulsion separating or curdling. At room temperature, the emulsions of the present invention are pourable liquids and are stable for extended periods of time. The emulsions of the present invention, when added during the manufacture of gypsum wood fiber composites, improve the water-resistance of the composite.

In another embodiment, the present invention provides a method for making an emulsion, including the steps of:

(a) heating to a temperature ranging from about 185°F to about 210°F a mixture containing at least one wax, an alkyl phenol, and at least one surfactant to provide a wax phase mixture;

(b) heating to a temperature ranging from about 185°F to about 210°F a mixture containing polynaphthalenesulfonic acid, an alkali metal hydroxide, and water, to provide a water phase mixture;

(c) adding the water phase mixture to the wax phase mixture to provide a mixture;

(d) homogenizing the mixture of step (c); and

(e) cooling the homogenized mixture at a rate effective to control the stability and viscosity of the homogenized mixture.

Another embodiment of the invention is directed to a gypsum wood fiber composite manufactured using the emulsion of the present invention and a conventional paper making process.

A further embodiment of the present invention is an emulsion containing a first wax having a melting point of at least 120 °F in an amount of about 30 wt. % to about 45 wt. % by weight, based on the total weight of the emulsion; a saponifiable wax in an amount from

about 3 to about 5 wt. %, based on the total weight of the emulsion; a combination of surfactants in an amount from about of about 0.5 to about 5 wt. %, based on the total weight of the emulsion; an alkyl phenol in an amount from about of about 0.5 to about 10 wt. %, based on the total weight of the emulsion; a polynaphthalenesulfonic acid in an amount from about 0.25% to about 5 wt. %, based on the total weight of the emulsion; water in an amount from about 45 to about 65 wt. %, based on the total weight of the emulsion; and an alkali metal hydroxide in an amount from about 0.5% to about 3 wt. %, based on the total weight of the emulsion.

DETAILED DESCRIPTION OF THE INVENTION

The Gypsum Wood Fiber (abbreviated as 'GWF") product differs from conventional gypsum wallboard products in that the GWF incorporates into the established slurry both gypsum and wood fibers in a unique combination and ratio of from about 5 to 50 parts of wood fiber to a corresponding quantity of gypsum to achieve a 100% combination in a mixed form. Unlike the production of gypsum wallboard which incorporates a slurry through a formation mechanism and which requires that any additives tributary to the slurry chemistry not affect the foamability and fluidity of the slurry during the manufacturing process, the production of GWF is facilitated through a conventional paper making process utilizing a wet end section headbox distribution mechanism distributing the GWF slurry onto a vacuum wire for initial mat formation and dehydration followed by compression through a series of vacuum belt rolls and into a kiln for final dehydration. The GWF of the present invention does not incorporate paper face and back paper but rather is a paperless core that has similar performance and uses comparable to conventional sheathing products currently available.

The unique combination and ratios thereof of a C_{24}-C_{36} and greater polymerized alkyl phenol, various waxes, co-surfactants selected from sorbitan esters such as fatty acid esters hexaoleate, polyoxyethylene sorbitan fatty acid esters, and a salt of polynaphalenesulfonic acid results in a stable wax emulsion suitable for incorporation into a GWF composite.

A preferred formulation is as follows in Table 1:

Table 1.

Raw Material Ingredient	WEIGHT %
145° F Melt Point Wax	37.9
Saponifiable Wax	5.0
C24 Akyl Phenol	5.0
Span 60	.3
Tween 60	1.7
KOH	.1
Polynaphthalene sulfonic acid	1.0
Water	49.0

The process of water felting dilute aqueous dispersions of various fibrous materials is a well-known commercial process for manufacturing many types of paper and board products. In this process, an aqueous dispersion of fiber, binder and other ingredients, as desired or necessary, is flowed onto a moving foraminous support wire, such as that of a Fourdrinier or Oliver mat forming machine, for dewatering. The dispersion may be first dewatered by gravity and then dewatered by vacuum suction means; the wet mat is then pressed to a specified thickness between rolls and the support wire to remove additional water. The pressed mat is then dried in heated convection or forced air drying ovens, and the dried material is cut to the desired dimensions.

An embodiment of the invention is further directed to a method for making a gypsum wood fiber article, which includes the steps of:

(a) mixing a slurry containing from about 5 wt. % to about 50 wt. % of a wood fiber, from about 5 wt. % to about 50 wt. % of gypsum, from about 1 wt. % to about 3 wt. % of the emulsion of the present invention, based on the total weight of the slurry and water;

(b) distributing the slurry onto a vacuum wire for formation of a mat;

(c) partially drying the mat of step (b);

(d) compressing the mat of step (c) through a series of vacuum belt rolls; and

(e) drying the compressed mat of step (d) in an oven.

The amount of water in the slurry is an amount sufficient to distribute the slurry onto a vacuum wire for the formation of a mat. Various gypsum wood fiber articles may be made by this method including, but not limited to, wallboard and sheathing.

A further embodiment of the invention is directed to a gypsum wood fiber article containing wood fiber, gypsum and the wax emulsion of the present invention.

In the manufacture of gypsum wood fiber wallboard products it is important to impart water-resistance to the finished product, so as to limit the maximum water absorption realized by the wallboard in a defined board soak test. For example, American Standards for Testing Materials ASTM 1396 and sub parts thereof describe such a test.

Preparation of Emulsions:

The term "wax emulsion", as used herein, means an aqueous emulsion of one or more waxes which is emulsified through the use of one or more surfactants. The wax emulsion must comprise a wax or waxes adapted to provide water resistance to the finished product. The wax or waxes must be inert with respect to the gypsum and wood fibers which make up the product.

Emulsions are prepared by heating the wax, an alkyl phenol, and at least one surfactant ("wax phase mixture") in one vessel and the water, polynaphthalenesulfonic acid, an alkali metal hydroxide ("water phase mixture") in another vessel. Both mixtures were heated, with mixing, to a temperature from about 185° F to about 210° F. Next, the water mixture was poured into the wax mixture under mixing. The resultant mixture was then placed in a homogenizer. With homogenization it is preferred that a distribution of micelle diameters ranging from about 0.6 micron to about 1.8 micron be achieved. However, the distribution of micelle diameters may range from about 0.5 micron to about 2.5 micron. This level of homogenization may be attained, for example, by using a dual orifice homogenizer operating at from about 2,000 to about 4,000 psig., preferably from about 2500 to about 3000 psig.

The homogenized mixture is cooled after the homogenization step at a rate effective to control the stability and viscosity of the homogenized mixture. The viscosity of the homogenized mixture ranges from about 30 to about 200 cps., preferably from about 80 to about 100 cps. It is most preferable that the homogenized mixture be cooled from approximately 185° F to about 100° F. This may be accomplished by running the

homogenized mixture through a cooling coil immersed in water maintained at room temperature.

HLB Values:

The hydrophilic/lipophilic balance ("HLB") value describes the relationship of a compound to its solubility in water. An emulsifier having a low HLB value will tend to be oil soluble and one having a high HLB value will tend to be water soluble. Typically, a water soluble emulsifier or blends thereof are used to make an oil/water emulsion typical of those described herein, or to solubilize oils or waxes, or to obtain some measure of detergent action. Thus, the HLB value can be used to describe or select the proper emulsifier or emulsifier system.

Where two or more components are combined, the HLB value of the combination is the weighted average of the individual HLB values. The following formula may be used to calculate the HLB value of a combination of materials:

$$HLB(combined) = \frac{Q_1x(HLB_1) + Q_2x(HLB_2) + \ldots Q_nx(HLB_n)}{Q_1 + Q_2 + \ldots Q_n};$$

where,

Q_1 = weight of material 1; HLB_1 = HLB value of material 1

Q_2 = weight of material 2; HLB_2 = HLB value of material 2

Q_n = weight of material n; HLB_n = HLB value of material n

Water Absorption Test:

Patties made in the Fluidity Test were dried for at least 24 hours at 110°F. At the end of this time, the patties were weighed and the weight was recorded. The dried patties were then immersed in water for two hours. At the end of the two hour immersion, the patties were weighed and this wet weight was recorded. Percent water retention was then calculated based on the difference between these two recorded weights.

Materials:

Various sources of gypsum may be used in the compositions of the present invention. The term "gypsum", as used herein, means calcium sulfate in the stable dihydrate state; i.e.,

$CaSO_4 2H_2O$, and includes the naturally occurring mineral, the synthetically derived equivalents, and the dihydrate material formed by the hydration of calcium sulfate hemihydrate (stucco) or anhydrite. The term "calcium sulfate material", as used herein, means calcium sulfate in any of its forms, namely calcium sulfate anhydrite, calcium sulfate hemihydrate, calcium sulfate dihydrate and mixtures thereof. Gypsum is available from most coal-burning power plants such as Duke Power or Kentucky Power.

The term "gypsum wood fiber" (GWF), as used herein, is meant to cover a mixture of gypsum and host particles, e.g, wood fibers. However, the amount of water required to hydrate a gypsum sample will vary with the purity of the sample. The amount of gypsum present in the mixture ranges from about 5 parts to about 50 parts, based on the total weight of the mixture. The wood fiber is commonly referred to in the art as wood furnish. Examples of wood fiber include, but are not limited to, softwood sources such as pines, spruces and firs, and hardwood sources such as oaks, maples, eucalyptuses, poplars, beeches, and aspens.

Waxes useful in making the various embodiments of the present invention may be selected from any of the commercially known waxes which have a melting point of from about 120° F to about 150°, and preferably from about 135°F to about 145°. Such waxes are typically of low volatility, exhibiting less than about a 10% loss in weight during standard thermogravimetric analysis. Also, the oil content of these waxes is typically less than about 1% by weight. These waxes are of a relatively high molecular weight, having an average chain length of C_{36}, that is a 36 carbon chain length, or greater. A preferred wax is Honeywell 3816. The wax is present in an amount ranging from about 30 to about 45 wt. %, based on the total weight of the emulsion.

A preferred combination of waxes is a combination of montan wax and Honeywell 3816. In this preferred embodiment, the amount of montan wax present ranges from about 3 to about 5 wt. % and the amount of Honeywell 3816 present ranges from about 30 to about 45 wt. %, based on the total weight of the emulsion.

In certain embodiments, it is useful to saponify one or more of the waxes. In this way, the saponified wax functions as an added surfactant. Waxes useful in this respect are limited to waxes having an acid value or a saponification value and a melting point greater than about 180° F. Saponification of such waxes may be accomplished by combining the

wax with a strongly basic material such as sodium hydroxide or potassium hydroxide. Waxes which may be saponified in the emulsions of the present invention include montan wax, carnauba wax, beeswax, bayberry-myrtle wax, candelilla wax, caranday wax, castor bean wax, esparto grass wax, Japan wax, ouricury wax, retamo-ceri mimbi wax, shellac, spermaceti wax, sugar cane wax, wool-lanolin wax, and others. The amount of strongly basic material needed to saponify a wax may be calculated based on the saponification value of the wax. For example, the saponification value divided by 1000 equals the grams of potassium hydroxide to add per gram of wax.

The alkali metal hydroxide is selected from the group consisting of sodium hydroxide and potassium hydroxide. The amount of alkali metal hydroxide present in the emulsion ranges from about 0.5 to about 3.0 wt. %, based on the total weight of the emulsion.

Surfactants include, but are not limited to sorbitan esters. Examples of suitable sorbitan esters include, but are not limited to fatty acid esters hexaoleate, polyoxyethylene sorbitan fatty acid esters, and combinations thereof. The amount of surfactant in the emulsion ranges from about 0.5 to about 5 wt %, based on the total weight of the emulsion.

More than one surfactant may be employed in the emulsion. A preferred combination of surfactants is a sorbitan monostearate and a polyoxyethylene sorbitan monostearate, wherein the combination of surfactants is present in an amount ranging from about 0.5 to about 5 wt. %.

Incorporating alkyl phenols into the emulsions has been found important to achieving low water absorption in the final gypsum wood fiber product. As used herein, "alkyl phenols" refer to phenolic compounds having a long chain alkyl group. The long chain alkyl group may be straight or branched. The long chain alkyl group may be $C_{24} - C_{34}$ (from 24 to 34 carbon chain length). Such alkyl phenols include long chain, $C_{24} - C_{34}$ (from 24 to 34 carbon chain length) polymerized methylene-coupled alkyl phenol, phenate salts, calcium phenates, long branched chain calcium alkyl phenols, long straight chain calcium alkyl phenols and complex polymers of maleic acid with and without an amine group substitution. One example of an alkyl phenol useful in the compositions of the present invention is described below.

Identification No.	Description	Source
319H	$C_{24} - C_{34}$ polymerized methylene-coupled alkyl phenol	Lubrizol Chem. Corp. Wycliffe, Ohio

The amount of alkyl phenol present in the emulsion ranges from about 0.5 to about 10 wt%, based on the total weight of the emulsion.

Starch compounds such as acid-modified, hydroxyethylated, oxidized, and/or cationic may also be added to the emulsion. The amount of starch ranges from about 0.1 to about 2 wt.%, based on the total weight of the emulsion.

Bactericides/fungicides can be included in the present invention. An example of a bactericide fungicide is METASOL D3TA, which is 3,5-dimethyl-tetrahydro-1,3,5,2H-thiadiazine-2-thione. METASOL D3TA may be obtained from Ondo-Nalco, Houston, Texas.

A salt of polynaphthalenesulfonic acid is required by the present invention. An example of a polynaphthalenesulfonic acid is DISAL GPS. The polynaphthalenesulfonic acid and an alkali metal hydroxide are reacted to give a salt of the polynaphthalenesulfonic acid. DISAL GPS may be obtained from Handy Chemical, Montreal, Quebec, Canada.

Wax Emulsions including Polynaphthalenesulfonic Acid

Table 2 below provides examples of emulsions made according to the embodiments of the present invention. Weights are expressed in terms of grams.

Table 2.

Ingredients	Example 1	Example 2	Example 3
Honeywell 3816D	33.00	37.90	37.90
Polyphenol 319H	0.50	5.00	5.00
Montan Wax	1.50	5.00	5.00
Span 60	0.15	0.30	0.30
Tween 60	0.85	1.70	1.70
45.5% KOH		0.10	0.10
Disal GPS			1.00
Starch	1.63		
Borax	0.38		
Water	61.25	50.00	49.00

WHAT IS CLAIMED IS:

1. An emulsion comprising:

at least one wax;

an alkyl phenol;

at least one surfactant;

polynaphthalenesulfonic acid;

an alkali metal hydroxide; and

water.

2. The emulsion of claim 1 wherein the alkali metal hydroxide is selected from the group consisting of sodium hydroxide and potassium hydroxide.

3. The emulsion of claim 1 wherein the alkyl phenol is a $C_{24} - C_{36}$ polymerized methylene coupled alkyl phenol.

4. The emulsion of claim 3 wherein the $C_{24} - C_{36}$ polymerized methylene coupled alkyl phenol is present in an amount from about 0.5 to about 10 wt. %, based on the total weight of the emulsion.

5. The emulsion of claim 1 wherein the surfactant is selected from the group consisting of a sorbitan ester, a polyoxyethylene sorbitan ester, and combinations thereof.

6. The emulsion of claim 5 wherein the sorbitan ester is sorbitan monostearate.

7. The emulsion of claim 6 wherein the sorbitan monostearate is present in an amount from about 0.5 to about 5 wt. %, based on the total weight of the emulsion.

8. The emulsion of claim 5 wherein the polyoxyethylene sorbitan ester is polyoxyethylene sorbitan monostearate.

9. The emulsion of claim 8 wherein the polyoxyethylene sorbitan monostearate is present in an amount from about 0.5 to about 5 wt. %, based on the total weight of the emulsion.

10. The emulsion of claim 1 wherein the surfactant is a combination of sorbitan monostearate and polyoxyethylene sorbitan monostearate.

11. The emulsion of claim 10 wherein the combination of sorbitan monostearate and polyoxyethylene sorbitan monostearate is present in an amount from about 0.5 to about 5 wt. %., based on the total weight of the emulsion.

12. The emulsion of claim 1 wherein a first wax has a melting point of at least 120 °F, and a second wax is a saponifiable wax.

13. The emulsion of claim 12 wherein the first wax is present in an amount from about 30 to about 45 wt. % and the second wax is present in an amount from about 3 to about 5 wt. %, based on the total weight of the emulsion.

14. The emulsion of claim 1 wherein the polynaphthalenesulfonic acid is present in an amount from about 0.25 to about 5 wt. %, based on the total weight of the emulsion.

15. A method for making an emulsion, comprising the steps of:

(a) heating to a temperature ranging from about 185°F to about 210°F a mixture containing at least one wax, an alkyl phenol, and at least one surfactant selected from the group consisting of a sorbitan ester and a polyoxyethylene sorbitan ester, producing a wax phase mixture;

(b) heating to a temperature ranging from about 185°F to about 210°F a mixture containing polynaphthalenesulfonic acid, an alkali metal hydroxide, and water, producing a water phase mixture;

(c) adding the water phase mixture to the wax phase mixture to provide a mixture;

(d) homogenizing the mixture of step (c) at a pressure from about 2000 psig. to about 4000 psig.; and

(e) cooling the homogenized mixture at a rate effective to control the stability and viscosity of the homogenized mixture.

16. The method of claim 15 wherein the alkali metal hydroxide is selected from the group consisting of sodium hydroxide and potassium hydroxide.

17. The method of claim 15 wherein the alkyl phenol is a $C_{24} - C_{36}$ polymerized methylene coupled alkyl phenol.

18. The method of claim 15 wherein the surfactant is a combination of sorbitan monostearate and polyoxyethylene sorbitan monostearate.

19. The method of claim 15 wherein a first wax has a melting point of at least 120 °F, and a second wax is a saponifiable wax.

20. An emulsion comprising:

a first wax having a melting point of at least 120 °F in an amount of about 30 wt. % to about 45 wt. % by weight, based on the total weight of the emulsion;

a saponifiable wax in an amount from about 3 to about 5 wt. %, based on the total weight of the emulsion;

a combination of surfactants in an amount from about of about 0.5 to about 5 wt. %, based on the total weight of the emulsion;

an alkyl phenol in an amount from about of about 0.5 to about 10 wt. %, based on the total weight of the emulsion;

a polynaphthalenesulfonic acid in an amount from about 0.25% to about 5 wt. %, based on the total weight of the emulsion;

water in an amount from about 45 to about 65 wt. %, based on the total weight of the emulsion; and

an alkali metal hydroxide in an amount from about 0.5% to about 3 wt. %, based on the total weight of the emulsion.

21. A method for making a gypsum wood fiber article, comprising the steps of:

(a) mixing a slurry containing from about 5 wt. % to about 50 wt. % of a wood fiber, from about 5 wt. % to about 50 wt. % of gypsum, from about 1 wt. % to about 3 wt. % of the emulsion of claim 20, based on the total weight of the slurry and water;

(b) distributing the slurry onto a vacuum wire for formation of a mat;

(c) partially drying the mat of step (b);

(d) compressing the mat of step (c) through a series of vacuum belt rolls; and

(e) drying the compressed mat of step (d) in an oven.

22. The method of Claim 21 wherein the wax emulsion comprises:

a first wax having a melting point of at least 120 °F in an amount of about 30 to about 45 wt. %, based on the total weight of the emulsion;

a saponifiable wax in an amount from about 3 to about 5 wt. %, based on the total weight of the emulsion;

a combination of surfactants in an amount from about 0.5 to about 5 wt. %, based on the total weight of the emulsion;

an alkyl phenol in an amount from about of about 5% to about 10% wt. %, based on the total weight of the emulsion;

a polynaphthalenesulfonic acid in an amount from about 0.25% to about 5% wt. %, based on the total weight of the emulsion;

water in an amount from about 45 to about 65 wt.%, based on the total weight of the emulsion; and

an alkali metal hydroxide in an amount from about 0.5% to about 3wt. %, based on the total weight of the emulsion.

23. A wallboard made by the method of Claim 21.

24. A wallboard made by the method of Claim 22.

25. A sheathing made by the method of Claim 21.

26. A sheathing made by the method of Claim 22.

27. A gypsum wood fiber article, comprising:

(a) a wood fiber;

(b) gypsum; and

(c) a wax emulsion.

28. The gypsum wood fiber article of Claim 27, wherein the wood fiber is selected from hardwood and softwood sources.

29. The gypsum wood fiber article of Claim 27, wherein the wax emulsion comprises:

a first wax having a melting point of at least 120 °F in an amount of about 30% to about 45% by weight, based on the total weight of the emulsion;

a saponifiable wax in an amount from about 3% to about 5% by weight, based on the total weight of the emulsion;

a combination of surfactants in an amount from about of about 0.5% to about 5% by weight, based on the total weight of the emulsion;

an alkyl phenol in an amount from about of about 0.5% to about 10% by weight, based on the total weight of the emulsion;

a polynaphthalenesulfonic acid in an amount from about 0.25% to about 5% by weight, based on the total weight of the emulsion;

water in an amount from about 45% to about 65% by weight, based on the total weight of the emulsion; and

an alkali metal hydroxide in an amount from about 0.5% to about 3% by weight, based on the total weight of the emulsion.

ABSTRACT

Emulsions are provided which are useful in imparting water-resistance to gypsum wood fiber products. In one embodiment, the emulsions comprise a wax or a combination of waxes, an alkyl phenol, at least one surfactant, polynaphthalenesulfonic acid, and an alkali metal hydroxide.